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APPENDIX A

History, Legislation & Parallel Efforts

Introduction

The Commission on Information Management (IMC) recognized the need for an integrated statewide network a decade ago. With the assistance of the Department of Administration, Division of Telecommunications, this need led to the development of the existing Digital Data Network (DDN). The DDN network, implemented in 1989, consolidated existing networks of the time and laid the foundation for future network projects. Another benefit was improved service because of controlled implementation, planning and competent network design. The IMC continued its efforts by sponsoring a series of planning sessions focused on State Information Architecture. The result was a vision for seamless, electronic government that would provide citizens with the ability to access government anytime and from anywhere in the state.

Legislation

2.1 Senate Bill 96-102 Statewide Information Infrastructure

This legislation added language to C.R.S. (Colorado Revised Statutes) 24-30-1702.5 focused on the statewide information infrastructure. This legislation regarded the establishment of a statewide information architecture to provide "all services offered to the public either free or at a set price, that employed the statewide telecommunications infrastructure to provide for the benefit of the public or private sector, text, video, image, sound, or data."

The intent of the General Assembly was to sponsor the development of a statewide telecommunications infrastructure that linked urban and rural communities across the state and facilitated citizen access to government and public entity information. Applications that would be supported by this network were distance learning,

telemedicine, telecommuting, and access to government information. This infrastructure development initiative was aligned with local economic development through the availability of telecommunications services.

By statute, the Commission on Information Management (IMC) has been charged with the following duties:

- Develop and implement requirements for statewide information infrastructure based on present and future user applications.
- Review existing portions of the statewide information infrastructure to determine the areas of the state in which it exists, whether it is adequate and usable for present and future user applications.
- Define and initiate public-private partnerships for funding and building the statewide information infrastructure, with the understanding that the private sector will build the necessary portions of the infrastructure.
- Initiate a system to manage the network in the most economical and effective manner, including designation of a system usage manager.
- Oversee ongoing use of the statewide information infrastructure.
- Recommend, if necessary, further legislation and budget appropriations for ongoing implementation of the statewide information infrastructure.

Senate Bill 96-197 Technology Learning Grant and Revolving Loan Program

In support of distance and technology learning a new article, 11.5 was added to Title 23 of the C.R.S. This article introduced two new phrases, "Colorado's information technology infrastructure" and "Multiple-use network". The latter was defined as "a digital network capable of carrying integrated voice and video as well as text, graphics, and other electronic data between and among schools, public libraries, institutions of higher education, and state agencies."

C.R.S. 23-11.5-104 charged the Department of Higher Education, in consultation with the Department of Education and Information Management Commission (IMC), to "investigate all private and public multiple-use network alternatives and select one or

more multiple-use networks to connect Colorado schools, public libraries, and institutions of higher education for the purposes of enhancing instruction and information access."

Other Statutes

C.R.S. 24-30-1804 instructs institutions of higher education in Colorado that use telecommunications programs or operations, to cooperate in the establishment of a statewide telecommunications network. It charges the Colorado Commission on Higher Education (CCHE) to facilitate the establishment of such a network, by promulgating rules and regulations requiring one, in the event it has not been established by July 1, 1992.

The legislation (C.R.S. 24-30-1801) encouraged the "coordination of such facilities and services, particularly among the governing boards of the institutions of higher education, the Department of Education, and the school districts across the state, would result in improving education programs and a more cost-effective telecommunications system."

Parallel Efforts

Connect Colorado (C-squared)

A group that reflected the goals of Senate Bill 96-197 to bring services to all the schools in the state was Connect Colorado. This organization, conceived by the Department of Higher Education, was composed of higher education, state government, libraries, and K-12 representatives. Connect Colorado's goal was to address the need for an improved and extended telecommunications infrastructure. This was to be developed for improved and cost effective services to the citizens of Colorado. The group recognized that a single network could effectively meet the need for varied communication and information needs of government, health care, and education.

Connect Colorado identified these potential benefits.

- outreach to the citizens of Colorado through improved connectivity
- strong position to leverage prices and services
- encouraging private sector expansion of telecommunications services in the state

- encourage commitment to developing telecommunication facilities in local communities
- promote economic development
- commitment to ongoing planning and coordination

The success of Connect Colorado was dependent upon the following outcomes:

- establishment of strong public/private partnership
- well articulated and definite commitment from communities
- an approach to exploit and improve upon of the existing telecommunications infrastructure
- utilizing the extensive experience which exists in the state

APPENDIX B

Assessment

Overview

The purpose of this overview is to present an objective assessment of current state networks, and how they interact with the current telecommunications environment in Colorado. It will provide backup information used to aid in the formulation of the general strategies set forth in the main document. This section of the document should be considered a work in progress, and will be revisited and edited, as information that is more complete becomes known.

The State of Colorado has a number of single purpose networks. A single purpose network is one that is designed and implemented for a single application, department or program. Although this practice is not necessarily detrimental to the operation of the state network resource, it does have long term implications that are becoming evident. This assessment will begin the process of determining this effect, and will point out issues that will affect future network projects.

While some of these networks are aggregated, and operated over common facilities, there is limited unified planning to maximize this resource. The state departments and organizations must develop a broadened mindset resulting in the development of a unified effort to invest funds wisely. This effort must be focused on meeting the rising expectations of state agencies, institutions of higher education, local schools and libraries. The expectations of state government must be bonded with local community requirements for enterprise and business development.

Telecommunications has seen dramatic changes in technological capabilities. However, in order to realize the benefits of advancing technology, offering more services and increasing capabilities, the state must recognize the need to develop a stable infrastructure based on the best technology available. This should be considered a more favorable alternative to individually upgrading a series of networks to meet short-term demand. Through the simple tactic of unifying and focusing efforts, the State of Colorado can ensure that maximum value is achieved in the shortest period.

The Purpose

Contained in this appendix are the following:

- Assessment Methodology
- Current Status of Networks
- Current Projects and their Associated Budgets
- Write-ups From
    - Higher Education
    - K-12
    - Library
    - Health Care.

Summary

Only by objective assessment and constant re-evaluation of the ever-changing environment can the state develop a reasonable technology plan for the future. Through this iterative process, effective means of using new technology will be conceived for use by government entities for the capable delivery of services to the citizen. This section presents a first look at the current climate and begins to document the status of networking for future needs analysis.

Methodology

During the summer of 1997, the Colorado Information Technology Services (CITS) Division of General Support Services in conjunction with the Commission on Information Management (IMC) began an analysis of the states' telecommunications infrastructure. The analysis was focused on the function and structure of the existing government and higher education networks and the overall telecommunications environment within the State of Colorado.

Based upon the preliminary findings of that analysis, and under sanction of SB96-102, it was determined that an interdepartmental taskforce should be formed. The task force would investigate known issues, isolate new ones and prepare a statewide strategic plan to address the future development of telecommunications infrastructure and state networks. The Multi-use Network Taskforce (MNT) was formed in October 1997, and staffed with three full time members and five part time members. It was critical that members representing the Departments of Higher Education, Education (K-12), General Support Services, the Information Management Commission (IMC), State libraries, non-profit health care providers and the private sector be included in this group.

Areas of Emphasis

The MNT identified several areas for its initial focus. A primary focus was placed on a statewide business needs assessment to determine the future directions and needs of state government. This was accomplished by meeting with state government departments, higher education schools and organizations, the Department of Education representing the interests of K-12 education and libraries, and consultants working with the non-profit health care providers. Information gathered in this phase detailed the projects that were being considered, provided in the context of future technical and policy administration.

The personal interview notes and network diagrams gathered through this assessment process were compiled into a central knowledge base and were used to validate the

concepts comprising the strategy to assess the Statewide telecommunications infrastructure. In addition to personal interviews, an all-day meeting was held on December 11, 1997 for representatives of Higher Education, Education (K-12), State libraries and various BOCES's throughout the state. This meeting focused on the reaction of this group to ideas developed by the MNT, and gathered comments and valuable firsthand information. Additional information was assembled by reviewing the various department IMAP's submitted to the Commission on Information Management (IMC) related to or affecting a Statewide telecommunications infrastructure.

For the purposes of internal influences, a database containing circuit information for all State of Colorado entities was created. The development of the database is continuing and will be an on-going task. It is important to note that data presented from this database must be considered a snapshot of what is known at the time of printing.

Data fields in this database include circuit type, function, bandwidth, termination points, and monthly costs. This information is used to help identify the most appropriate points of aggregation and the effect on site cost of any action taken. The initial database development was focused on compiling the circuit information on all circuits known to CITS Telecommunication Services Group. It is the belief of the MNT that this represents approximately 60% of the existing state funded infrastructure. The additional network infrastructure identified through the business needs assessment along with the network components of future projects will be added to this database to provide a progressive picture of the States telecommunications infrastructure.

From an external perspective, the task of reviewing the strategic planning efforts of other states in the area of telecommunications began. The MNT reviewed the published strategic plans of other states. By doing this review, it was hoped that the State of Colorado would learn from the successes and failures of other states regarding telecommunications. The MNT used Internet research and telephone interviews to compile a library of reference material. This information will be processed and incorporated into the final plan where appropriate.

Other external influences were reviewed by meeting with the Public Utilities Commission staff; carriers, hardware and software vendors and local groups facing the challenge of

lack of advanced services. It is clear to the MNT that the development of telecommunications infrastructure is dependent upon regulatory issues such as network interconnect regulations and standards. Other equally important facets of the regulatory environment include discount rate indexing effecting competitive local exchange carriers, and the development of a universal service fund as suggested in the Telecommunications Act of 1996. The state PUC is beginning to evaluate the use of the state USF to fund advanced services. The MNT is supportive of this evaluation.

The MNT also met with representatives from various technology-based companies to determine product availability to assure that technical assumptions were backed by existing products. These vendors were asked to provide catalogs, product descriptions and company directions to the MNT. Surprisingly, some vendors chose not to provide requested information, or provided incomplete details of their companies and products.

A library of information related to the areas mentioned above will be maintained by the MNT as an ongoing reference source for future planning and coordination.

The Process

An interactive and iterative process has been developed as a mechanism for identifying the requirements of a statewide telecommunications infrastructure. This iterative process includes the following steps:

1. Gather/Share detailed telecommunications information;
2. Define/Challenge assumptions related to telecommunications infrastructure;
3. Document the findings
4. Repeat the process

This process will continue to foster the development of sensible strategies and tactics to ensure success of the plan. It will provide backup data for review by financial, technical and policy analysts.

Summary

By using this iterative process, the MNT seeks to provide a continually refined model of the telecommunications infrastructure resulting in increased logic for planning strategy. By design, every cycle of the process improves the assumptions and provides better information to decision-makers.

Current Status Of State Networks

The purpose of this portion of the appendix is to outline the status of state government networks. To facilitate this analysis, several parties were contacted and interviewed as described in the previous section entitled Methodology. This analysis, still in its preliminary form at this printing, does provide some insight into the successes and failures of state government network projects and development.

State Agencies

The following section describes how the various state agencies operate their networks. There are 19 state departments in Colorado. The MNT analysis has classified them into four groups depending on how they operate their telecommunications networks. The first group is general state government, the agencies responsible for the general services of the state. This group includes Labor and Employment, Human Services, Public Safety, Transportation and others. The second category is under Higher Education. This category includes the four-year colleges and university system in Colorado. The third is the community college system run by the Colorado Community College and Occupational Education System (CCCOES). Finally, the last group is the Judicial Branch and others. Each of these groups is somewhat autonomous in the planning, management and operation of their telecommunications projects and networks.

General State Government

The Telecommunications Services Group under Colorado Information Technology Services (CITS) in the Department of Personnel is responsible for assisting general state government agencies to design and complete their network and telecommunications projects. This group was formerly known as the Division of Telecommunications, and was an organization within the Department of Administration, now consolidated into the Department of Personnel. Telecommunications Services serves as consultants to the network staff from the various state agencies for many network projects. They also

operate the state Digital Data Network (DDN), the Colorado Information Network backbone (CIN), the CITS Data Center Systems Network Architecture (SNA) network and the Cooperative Interactive Video in Colorado State Government (CIVICS) video network. It is important to note that the responsibility for several networks such as those in higher education and Judicial were delegated from Telecommunications Services to the appropriate agency.

Telecommunication Services develops specifications for some statewide contracts such as routers, modems and other telecommunications equipment. It also analyzes orders and makes suggestions based on information provided to ensure that the state gets the best values for its investments.

Higher Education

Higher Education Networks are designed and implemented by the school or university needing service. Each college or university has either staff or outside assistance to plan and implement their networks. The main organizations in this environment are the University of Colorado, with campus locations at Boulder, Denver and Colorado Springs; Colorado State University in Fort Collins with extension services throughout the state, the University of Northern Colorado in Greeley, Fort Lewis College in Durango, Western State in Gunnison, Adams State in Alamosa, Mesa College in Grand Junction and the University of Southern Colorado in Pueblo.

Higher Education uses the Internet (Supernet Inc.) for much of its intercampus electronic mail and traffic. It is also a user of the CITS CIVICS network for videoconferencing and distance learning. The evolution of distance learning, telemedicine from medical and veterinary schools dictates the implementation of a high capacity higher education Intranet for the provision of these services. Another factor effecting the future of higher education networks is the deployment of Internet II, the next generation Internet. It will require high-speed advanced services between major campuses and to a major backbone network provider.

Community College Systems

In addition to the colleges and universities of the Department of Higher Education, Colorado also has a large community college system. Community Colleges are located at Sterling, Trinidad, Fort Morgan, Denver metro area, Pueblo, Lamar and La Junta. The community college network provides service between these cities and the Colorado Community College office in Denver. The network system uses the CITS CIVICS network for distance learning and videoconferencing. It also uses the DDN and carrier circuits to connect the various sites. CCCOES is connected to the Internet through Higher Education.

Judicial Branch and others

The other organizations not mentioned above are Judicial, K-12 education and the library systems. The Judicial network was developed at the departmental level. The Judicial Branch of government has staff and does network design, operation and purchasing separately from any other group.

The K-12 education network is largely composed of schools connecting to the Internet through an Internet service provider. Some are connected through the Department of Higher Education and others through the community college system. The Colorado Department of Education helps facilitate Internet connections and may serve as a technical resource to the school districts.

Many libraries are connected to Access Colorado Library & Information Network (ACLIN) through the Internet. ACLIN facilitates card catalog sharing through the Colorado Alliance of Research Libraries or CARL. The State Librarian administers ACLIN.

Backbone Network Services

The "backbone" network is the segment of the network over which telecommunications services are distributed to departmental networks. A telecommunications backbone is typically a high-capacity core network that carries traffic destined for other networks.

The vast majority of the state's networks are carried over telecommunications lines leased from private telecommunications suppliers. The state has operated a statewide microwave system primarily to support public safety radio applications for a number of years. Besides the Colorado State Patrol and local law enforcement, this system supports radio communications within the Department of Transportation (snowplows, highway equipment, etc.); Department of Natural Resources including the Parks and Wildlife divisions; Department of Corrections for communications within and between prisons; and Higher Education institutions primarily for security and maintenance applications. The microwave system has links to the systems in the states of Wyoming and New Mexico with a link to Utah currently in the planning stage. Another important role for the microwave network is to provide an alternate or redundant path in order to guarantee better up time for other statewide networks. For example, the DDN uses the microwave for redundancy of major backbone circuits.

A breakdown of the traffic carried on the microwave network shows that 59% is for Public Safety purposes, 17% supports the activities of the Department of Transportation, and the remaining 24% is used for all other traffic.

The state also has a connection to the Internet. The contract for Internet services was a joint activity of state government and higher education to aggregate need for discounted cost. This activity was highly successful in bringing quality services at low price for all.

The common carrier provided leased lines used for the networks are of various types. The technology list consists of analog leased lines with 9600 bits per second (BPS) modems and digital data lines commonly at DS-1 (1.54 million bits per second or MBPS) rates. Newer technology using frame relay methodology are most commonly supplied at

the 64KBPS (64,000 bits per second) or DS-1 rates, with DS-3 (45 megabits per second or MBPS) rates now available. The terms DS-1 and DS-3 are used here in place of the more commonly used T-1 and T-3 terminology; for the purposes of this document they describe the same technology. The latest technology is Asynchronous Transfer Mode (ATM) service that is capable of voice, video, and data traffic. These lines are acquired from a variety of suppliers with U.S. West being the predominant supplier. The state usually supplies the terminating equipment such as modems, Private Branch Exchanges (PBXs), routers, etc. that connects these leased lines. This equipment is commonly known as customer premise equipment or CPE in the industry.

Voice Communications

Voice communications is characterized by the public telephone network. Some refer to this as POTS (Plain Old Telephone Service) bringing to mind the old dial black telephones that everyone once had. The state currently supports 30,000 telephone numbers located throughout the state excluding Higher Education and their student populations.

Typically, CITS Telecommunications Services guides a department through the acquisition of an appropriate telephone switch and appropriate carrier service for the unit. The analysis done by Telecommunication Services determines whether the requirements are better satisfied by a small key system typically used for small offices or a larger PBX (Private Branch Exchange) commonly used in highly concentrated areas. The PBX at the Capitol Complex and the Kipling Complex are two examples of systems managed by this group. The voice management duties also include the state long distance telephone charges contract. Long distance charges as well as the charges for the State cellular contract are typically re-billed to agencies. The long distance contract annually passes through $3.5 million in charges at a substantial discount from normal rates by aggregating demand. In July of 1997, the state had one million minutes of long distance with 500,000 minutes billed by U.S. West, 400,000 minutes from MCI, and the balance over dedicated facilities for the state.

Analog Radio

While the microwave is digital, the normal radio communications are still analog. The state system supports approximately 9900 radios and related dispatch centers. The state has almost 8100 radios with the highest concentrations in Transportation (almost 2700), Natural Resources (over 1500), and Corrections (over 1600). Other departments using this service include Agriculture, General Support Services, Judicial, Education, Public Health & Environment, Higher Education, Human Services, Labor & Employment, Law, Local Affairs, and Revenue. The other approximately 1800 radios are located in city and county governments primarily in local law enforcement and fire protection. The Colorado State Patrol is currently in the process of transitioning from 17 dispatch centers down to five strategically located throughout the state.

The Federal Communications Commission (FCC) has reallocated bandwidth to support the new applications such as cellular telephony and personal communication systems. To satisfy the consequences of this action, the state must upgrade its radio network to meet new standards that take effect in the year 2005. One of the complexities of this mandate is that the standards force everyone to get to the same place at the same time. A mixed network of old and new technologies creates a number of problems when trying to share the same network.

Digital Data Network (DDN)

The Digital Data Network (DDN) was created in 1986 to combine and better facilitate the transmission of data traffic within the state. The DDN consists primarily of leased digital lines with some reliance on the digital microwave for alternate paths or redundancy. The DDN is a multiplexed network that consolidates low bandwidth applications such as SNA lines from the CITS Data Center, which are in the 9600 BPS range. This network, through route redundancy and diversity raised the average availability of the networks to the 99% range, and decreased costs by an average of 25%.

The Digital Data Network exists as a superhighway around the State of Colorado which relies on individual "tail circuits" to connect each agency to the super highway. The network relies on Time Division Multiplexers from General DataCom (GDC), and

consists of nearly 65 nodes and almost 430 circuits. DDN carries primarily low speed SNA network (9600 BPS) data and CIVICS video network traffic.

SNA Network

The SNA network is so named because it uses the Systems Network Architecture (SNA) protocol. It is the network architecture used to interconnect IBM type mainframes such as Hitachi GX-8624 at the CITS Data Center and generally supports the widely used 3270 terminals common to many departments. SNA is also used to connect the state mainframe to other mainframes for intercommunications.

The use and expansion of the SNA network has been discouraged, however, the state data center still has over 9640 devices identified as SNA devices. These devices are connected to 640 controllers running over 240 lines. On a sample day, this network was handling an average of 16,715 messages a minute between 7 a.m. and 4 p.m. The calculated average is 72 messages per line per minute. Ultimately the use of this protocol, at least on the backbone part of the statewide network needs to be phased out in favor of the State standard, which is the TCP/IP protocol. This network is currently being monitored by the NETCON 90 software for the purposes of identifying and troubleshooting problem lines. It should be noted that this is the most labor-intensive network currently operated by the State.

CIVICS Network (Video Teleconferencing)

The Cooperative Interactive Video In Colorado State government (CIVICS) network provides the delivery of interactive video conferences and classes to 48 sites located around the state. The network serves video applications (primarily at higher education institutions and correctional facilities). In the last year, CIVICS has grown from 17 to 48 sites with port hours increasing from 300 to 1146 per month.

Currently, most of this activity runs on the DDN. The CIVICS network offers two-way interactive video using at least 384KBPS of bandwidth. Due to the time division multiplexer technology used in the DDN, 384KBPS of bandwidth must be permanently dedicated whether or not a videoconference is taking place.

There are increasing capacity issues as demand grows for this service other than the bandwidth constraints mentioned previously. Under the current video bridging technology, there is a limit of three cascading ports when connecting multiple locations to the network. This means that there are limitations regarding the number of sites that can be connected to a conference.

The highest usage is for course delivery between colleges, universities, and community colleges. Currently classes are being taught remotely between university campuses. There is also a growing trend to connect with high schools around the state to increase the course offerings available. This is especially true in rural areas. The University of Colorado Health Sciences Center (UCHSC) is using this service to teach continuing education classes for nurses at remote locations around the state known as Area Higher Education Centers (AHEC). There also is currently a trial between UCHSC and the correctional facility at Limon. This trial will demonstrate the ability to perform remote medical consultation for prisoners by using video tools to connect the clinic in Limon with a doctor in Denver. Another use for video by the Department of Corrections is video teleconferencing, which will be used to training staff and inmates, as well as provide services for video arraignment, parole board hearings, and staff meetings.

Colorado Information Network (CIN)

This network is primarily based on Frame Relay technology from U.S. West Communications. It also uses the Department of Defense TCP/IP protocol suite as its primary protocol, but also routes Novell IPX and Banyan Vines. The use and expansion of the Novell and Banyan protocols has been discouraged under the state WAN (Wide Area Network) standards to simplify the operation of the network.

The CIN has network connections to most departments, and serves as a transport to the CITS Data Center mainframe and to the Internet. Through the CIN, departments with compatible network protocols can interconnect and communicate with one another. The CIN also connects the state network to the global Internet.

Due to the current state of technology, and the characteristics of the frame relay protocol, only data is carried over this network. Considerable work is being done by vendors to add multimedia services (voice and video) to frame relay. However, it is too early to predict the outcome of this endeavor.

Increasingly, agencies using network technology other than TCP/IP protocols have employed LAN gateways (with some success) to emulate the 3270 terminals used in the SNA technology. Other agencies using TCP/IP protocols have used TN3270 software on personal computers to achieve this goal with more success. These connections still only have the capabilities of a dumb terminal.

This network is monitored by the Open View network software from Hewlett-Packard using a protocol called SNMP (Simple Network Management Protocol). SNMP is an industry standard for monitoring and even managing resources on a network.

There are various structural components of the CIN network besides frame relay circuits. There is a high-speed fiber optic loop connecting the buildings in the Capitol Complex area. This fiber optic ring uses FDDI (Fiber Data Distributed Interface). FDDI is a network architecture using token passing mechanisms and is sanctioned by various standardization bodies.

There are currently more than 220 routing points on this network using primarily Cisco routers. The CIN has over 6000 countable devices attached to the network. It is difficult to obtain an exact figure about the total number of nodes attached to the network, as the nodes existing behind the various network gateways do not register in the network management systems.

A recent sample was run over three days to determine the amount of traffic on this network. The major nodes through which all traffic passes were specifically monitored for usage. Over three-day period, almost 12 billion packets of information passed through these routers. The router located at the data center sent or received over 8 billion packets in those three days. These numbers would give an average daily traffic of almost 4 billion packets. If you further narrow the day and assume that the majority of traffic

occurs between 7 a.m. and 4 p.m. then 7.35 million packets are being passed over this network each minute. This traffic volume is evidence of the high usage of this network.

The state web server (Colorado Homepage) uses the CIN to connect to the Internet. The web server is on the "open" CIN (OCIN), which is accessible to the Internet without restriction. The placement of the web server on this portion of the CIN is necessary to allow the web server to interact with web browsers connecting to it from all parts of the world. The major part of the CIN is behind a screening router serving to provide a barrier to Internet incoming traffic.

Asynchronous Transfer Mode (ATM) Network

A new network is currently being installed which will dramatically replace the capabilities of the current Digital Data Network. This new network relies on a technology known as Asynchronous Transfer Mode or ATM. This technology is also known as cell relay. ATM relies on re-assembling data into individual 53 byte cells. The advantage of grouping the data into a fixed length cell is that the hardware can easily detect the cell boundary, and can thus switch the cell very quickly.

ATM provides differing quality of service for voice, video, or data to be carried over the same network. These different qualities of service profiles are necessary to provide competent end to end service for each of the three applications. As mentioned in the previous paragraphs, technology has limited the transmission of different types of traffic over the same network. ATM has overcome some of these limitations.

The ATM technology allows for the creation of virtual circuits, which appear to the end user as dedicated connections between two locations. In reality, the network provides virtual paths between the two locations, and uses the paths to determine traffic routing. The advantage to this technology is that the network configuration can be changed quickly to respond to varying traffic demands. Changing a virtual connection only takes minutes instead of weeks or months to install new copper or fiber circuits. The ATM network is planned to be the backbone network architecture. ATM can be run efficiently on SONET (Synchronous Optical Network) at rates such as OC-3c (155mbps) speeds or over DS-3 circuits at 45 MBPS. The architecture can be scaled up to much higher speeds

such as OC-12 (622mbps), or scaled down to DS-1 technology to accommodate small offices or remote locations lacking high capacity facilities. Phase I of the ATM project is currently underway which will install this technology in the Denver metro area. Phase IB will extend this capability to Colorado Springs and Pueblo. Phase II will extend the ATM network to Grand Junction and Durango. The second phase will put in place the basic backbone required to support a unified state network.

Higher Education Networks

Since 1986 when the first higher education institution connected to NSFnet, Colorado higher education, institutions have been involved with state and regional networking. Westnet was formed to aggregate regional traffic from Colorado, Wyoming, New Mexico, Utah, Arizona and parts of Idaho. Higher education used NSF (National Science Foundation) grants and campus staff to develop POPs which became Colorado SuperNet hub sites. The Internet has become a way of life for higher education. The development and use of the World Wide Web has led to large amounts of Internet traffic on campus backbones. Higher education relies on the Internet for their statewide network. College and university campuses are large and disperse. Distributing Internet access over the entire campus requires robust LANs. Some colleges and universities are using video services to conduct classes and there are numerous classes offered over the Internet. In fact, at least two institutions offer degree programs over the Internet.

The Higher Education community is also a heavy user of the CIVICS network for teaching classes either at remote campuses or between campuses. The University of Colorado has a fiber optic connection between the campuses in Boulder, Denver, Colorado Springs, and the Health Sciences Center. There is currently a plan under way to upgrade the CU fiber network to an OC-3c (155mbps) Asynchronous Transfer Mode (ATM) network. This connection will span the existing campuses and the new campus for UCHSC at Fitzsimmons in Aurora. There is also a trial ATM project for high speed Internet connections currently being conducted by the University of Colorado, Colorado State University (CSU); Colorado School of Mines; University of Colorado at Denver and the University of Northern Colorado (UNC); and the National Center for Atmospheric Research (NCAR). Basically these institutions are connecting to the

Internet through a U.S. West supplied ATM "cloud" to the Boulder campus of CU. The traffic is then aggregated on a high-speed ATM link to NCAR.

The Community College System also has a statewide network connecting all of the community colleges in the state for both data and video transmissions. The video network, which is an extension of the CIVICS network, reaches 12 main campuses and their satellite campuses. At least three major campuses for Denver, Aurora and Arapahoe Community Colleges and their satellite locations are being added this year to the video network through the Technology Learning Grants.

Many of the Technology Learning Grants that were awarded this year will drive up network demand for more connections. These grants will affect the number of connections between higher education institutions and local school districts. The Poudre Valley School District is planning to connect using wireless technology with the Fort Collins campus of Colorado State University in order to gain a more robust Internet connection. The Red Rocks Community College is extending T-1 links to Park, Clear Creek, and Gilpin counties. The Connect Colorado in the Arkansas Valley project will connect CU, CSU, Lamar Community College, and Otero Junior College with 28 school districts. The grant received by the Mountain BOCES will connect Adams State College and the two campuses of Colorado Mountain College with 58 schools using T-1 leased lines from U.S. West Communications. The RMOTE group will connect Western State College in Gunnison with the Gunnison, Mountain Valley (Saguache), and Hinsdale County School Districts. This particular project uses leased lines to connect to the state network to route traffic to Gunnison, which may be an excellent model for the future. The project is also sharing microwave towers with the local cable television company in order to connect with the schools in Crested Butte. The WestCel group is connecting Colorado Northwest College (Rangely), Western State College, Mesa State College, and Fort Lewis College with 35 video centers located in 18 school districts, two vocational-technical centers and a library district. This will be an ATM network. The Southwest Colorado Interactive Learning Network (SCIL-NET) will use frame relay at T-1 speeds to connect 13 libraries, 12 school districts with Fort Lewis College and Pueblo Community College-Cortez. Initially these will be primarily 56,000 bits per second (56 kilobits or 56kb) connections used for Internet access.

School (K-12) Networks

Currently the Colorado Department of Education connects with and shares information with the 176 school districts in the state through the Internet. A survey completed in the fall of 1996 attempted to assess the capabilities and current capacities of the school districts in the state. That study revealed that 84.6% of the school districts have an Internet connection with approximately 75% of all schools having some type of access. The Internet access for a school ranges from 70.4% for elementary schools to 80.6% for middle/junior high schools to 84.4% for high schools. Within the schools the median was three rooms used for instructional purposes that had Internet access. Within the school districts, 36.4% have the schools and other buildings connected to a wide area network. Of the school districts, 32.2% were participating in a distance learning project or program. There is wide variation between school districts and their use of this technology. The primary uses appear to be Internet access and Distance Learning applications between either schools or schools and colleges.

Library Network

In 1992, the Colorado State Library created the Access Colorado Library Information Network (ACLIN) to link the participating automated library catalog systems in the State. The main advantage to do this was to make them accessible via no-cost local or 800 line dial-up to everyone in Colorado. ACLIN provides free dial-up access (text only) to almost every automated library catalog in the State and a large number of selected databases and Internet-based information resources. This totals more than 230 resources in all. Since ACLIN is Internet-based, its resources are also available, in a fully graphical interface, to Colorado residents who have personal dial-up accounts or other access to the Internet.

Colorado is one of the leading states in the country regarding statewide library resources networking. Recent state and national surveys indicate that 73% of Colorado public libraries provide Internet access to their patrons ("*Coloradans--and Colorado Public Libraries--Top National Internet Norms*"; FAST FACTS, ED3/110.10/136).

Network Assessment

The State of Colorado has a number of network technologies. While many of these do operate over the same backbone, there is limited cooperation and unified planning to maximize this resource. We now have a requirement to invest significantly in a unified network because many of these individual networks have been developed over the years to fill a specific need. By going forward in order to meet the rising demands and global expectations of state agencies, institutions of higher education, and local schools. The area of telecommunications has seen dramatic changes in the technological capabilities available. Rather than individually upgrading a series of networks by agency (including higher education), a unified initiative needs to be put forward, agreed to, and then implemented. This initiative will seek to ensure that Colorado does not spend more than is necessary to fulfill the stated demands for network technology. The obvious benefit is to unify and concentrate our efforts to ensure that the maximum value is achieved in the shortest time. Another benefit of this initiative is to avoid the continuing limitations of current networks that were implemented based on short-term demand over the years.

At the same time there does appear to be at least the presence of disparate state networks in every county in Colorado. These networks are not currently compatible and are using different and in some cases outmoded protocols. The level of capabilities tends to vary more widely when assessing the networks used by institutions of higher education and local schools. The greatest disparities are at the local school level. Some of these are currently being addressed by the Technology Learning Grants that are now being implemented. Because that process is just beginning in terms of actual installations, it is more difficult to determine where network technology is lacking.

The other essential observation is that the vast majority of this network traffic is currently running over lines supplied by the private sector. A query of the state's financial system showed that the state spent over $17 million with telecommunications vendors. The key to any strategy going forward will be to concentrate our buying power to create incentives for the private sector to upgrade their equipment and capabilities. One method to facilitate this buying power is the aggregation of network traffic to create high demand for more advanced network services. If the private carriers refuse to make the investments, preferring the guaranteed profits of the status quo

which currently allows them to charge for several separate telecommunications lines, then the state's network capabilities will suffer.

Vision of the future

Government Access

In late 1994 and early 1995, the Commission on Information Management sponsored a series of meetings that were aimed at setting an Information Architecture for state government. The result of those discussions, which included representatives from every department (primarily program people as opposed to just technology people), was a collaborative solution.

The vision for government was one of seamless or electronic government. Any citizen should be able to access government and its services no matter where you are located in the state and largely regardless of the time of day or day of the week. Accessing government would include not only mundane things like obtaining licenses, getting copies of birth certificates, etc. but extend to obtaining new skills through remote training or performing extensive research. A citizen would be able to request a copy of their birth certificate on line. A nursing license could be renewed directly with a few questions answered. An income tax form could be filed directly electronically with your refund being deposited automatically in your bank account. Training through the local school or community college could be delivered from any higher education institution offering that course and ultimately delivered directly to the student at home. Extensive research of libraries or the Internet could also be carried out anywhere. General information about government, data gathered by government agencies or higher education institution research would be instantly available. All of this capability should be provided seamlessly to the citizen without having to visit a particular location during "working hours". For those that are "technology poor", the same access could be obtained by visiting the local school, library, or college where public terminals could be available. This vision requires the adherence to common standards and for the most part use of a common network or seamless connections between networks.

Telecommunications Development

The other factor to be considered is the present state of telecommunications in the state. This factor most often dictates the technology chosen to fulfill the demands of network applications. The current picture is not a good one.

Colorado has a concentrated front-range population which is gifted in its telecommunications service menu. Carriers are not required by regulation to provide advanced services such as ISDN (Integrated Services Digital Network), ATM, frame relay, or other technologies. The main reason to compel development of these services is economics. The carrier must often balance the requirement for these services, the long-term impact on the financial resources of the carrier, and the impact to local rates of use to recoup the cost of the technical investment.

Rural Colorado, because of low population density, and remoteness is a victim of this situation. Many areas are served by small LECs (Local Exchange Carriers) that may not have the financial resources to provide advanced services required. This situation has impeded the development of the telecommunications infrastructure in Colorado.

In order to meet the vision of seamless government, a point of presence or Aggregated Network Access Point (ANAP) must be established in every county in the state. The state must act as an "anchor tenant" to the local community. This role will require the state to pay for a high speed connection with the local telecommunications carrier to meet its needs and to act as a focal point for the development of telecommunications around the ANAP locations. In order to cost justify high capacity connections to every county seat, the demand for telecommunications networks in each county must be analyzed and combined as needed. The state currently has four to six separate networks using separate telecommunications lines running into each county. Examples of the networks having presence in each county are the Motor Vehicle/Secretary of State network for the county clerks; the Colorado Bureau of Investigation network for local law enforcement; the Human Services network for county welfare offices; and the Judicial network for all of the courts and probation offices. Large networks also exist for Corrections, Driver's

License offices, Job Service Centers, Transportation, and Natural Resources (Parks, Wildlife, and Water Resources) offices. These networks need to be combined to create a single connection running at least at T-1 (1.54mbps) speed probably in ATM mode.

Also by acting as an anchor tenant, the state will order local loop services to connect its offices to the ANAP. This will increase the demand on the carrier to provide advanced services. In concert with the activities of the state, it is hoped that the local community will bond to create local groups to provide increased demand to further effect the economic balance in favor of advanced services.

As our society shifts toward the 21st century workforce, the state needs to position itself to support a remote workforce that for the most part is telecommuting. With the increasing congestion on our highways and the new much stricter EPA regulations for pollution, there will be rising pressure to remove the largest workforce in the state from the highways and streets of Colorado. Doing this reduces the pollution and congestion by moving state workers to their homes. Since much of the work in state government is information based, this move can be accomplished without major dislocations. In order to support the workforce an entirely different support structure must be created. Robust help desks to deal with any technical problems must be formed and trained. State office buildings must be turned into common space that is assigned each day to those who need time in the office. Files must be moved either to the home or to the office location for that day. The ability to deliver equipment and supplies to a home office must be created. Once this infrastructure is created, the geographical location of a worker should not matter. This will lead to further network demand in the smaller communities of the state.

The state must also upgrade its current capability to support its mobile workforce. This workforce currently relies on the analog radio system to support its daily activities. As mentioned above, new FCC regulations will force us to upgrade our systems. This required upgrade offers an opportunity to increase the capabilities available to this workforce through a technology known as Digital Trunked Radio (DTR). This technology will allow for better service to a remote worker in the field. DTR will allow for more dynamic configuration of communications and allow for the first time the cross connection of different parties. Currently the Colorado State Patrol, the Department of Transportation workers, and Wildlife officers are on separate radio channels without the

ability to talk to each other. With Digital Trunked Radio, these disparate workers could cross connect on a common incident such as an injured deer on a highway as the result of a landslide. Not only will DTR allow for better connections to local law enforcement and emergency medical services but to other local mobile entities such as school buses. Digital Trunked Radio is another layer within the state backbone that supports a mobile workforce.

Services must be centrally acquired and managed in order to ensure that the state network remains robust and compatible. Primarily by statewide contracts with private sector providers, a network can be built and fully developed. The autonomy noted in the previous sections can be preserved somewhat, but a new level of cooperation must be required in order to make sure that the maximum amount of network resource is aggregated. The state should stop the current trend to return to a series of separate and less robust networks. The state and each local community must recognize their common goal of providing a common telecommunications infrastructure throughout the state in order to achieve the vision of seamless or electronic government.

Higher Education Networks

Authored By: Mollie A. McGill, University of Colorado, February, 1998

Colorado's higher education systems contribute directly to the economic and social well being of the state by offering a comprehensive array of quality technical, two-year, four-year, graduate and professional programs and by extending these programs through a number of outreach mechanisms. However, affordable and timely access to the state's higher education expertise and resources is not generally available to meet the growing demands from working adults and professionals, business leaders, teachers, school administrators, physicians, and medical professionals in cities and towns across the state. Access is just one of the challenges facing higher education in Colorado. Our colleges and universities will concurrently accommodate enrollment growth, improve the quality of undergraduate education, and ensure that its graduates have the necessary information processing and analytical skills to be productive in the 21stcentury. Technology and telecommunications hold promise for meeting these demands.

Constituencies and Needs that Could Be Facilitated through Improved Access to an Affordable, Reliable High Bandwidth State Network

Higher education's major challenge relevant to the topic of a state network is that of access. Many of our institutions have considerable experience and strong track records in extending access to their educational programs through various distance education, Telemedicine, and online education initiatives. The costs to design, create, and offer these quality outreach programs are great, and the additional high cost of telecommunications line connections are a major limiting factor to the expansion of such initiatives. We support MNT's goal of aggregating the state's bandwidth needs thus providing higher capacity at lower cost to all groups.

A high speed, high bandwidth data and video network, created in partnership with private telecommunications providers, would pave the way towards addressing these targeted education and health care needs:

Greater access to the educational programs and services offered by the state's colleges and universities, including:

- first and advanced degree opportunities for students and working professionals who have constraints relative to place and time,
- professional development short courses for businesses,

- lifelong learning opportunities for all Colorado residents,
- timely access to the library, research, and data resources of higher education for individuals and businesses,
- rapid access to critical information and training to a broad range of public constituencies.

Adding value to the undergraduate and graduate student learning experience by:

- providing students with the analytical and technology literacy skill require for employment in the 21st Century,
- engaging faculty and students in new approaches to teaching and learning, enabling new forms of communications and interaction,
- providing student support and administrative services (online admissions, course registration, and online catalogs) in an efficient and timely manner for both on and off-campus students,
- integrating new knowledge and new research into the learning experiences of students, and
- providing electronic access to experts and resources worldwide.

Working with K-12 schools and districts to assure that high school graduates are prepared for a successful transition to college by offering:

- college preparatory courses to high school students
- teacher in-service, and
- graduate teacher education via distance learning.

Improved health care service regardless of location:

- better quality medical care for patients at primary and secondary health care facilities,
- ongoing health professional education and support for rural physicians and other health care providers, and
- a vital communications link for hospitals and health care centers throughout the state, resulting in their improved economic viability within a community.

Desired Technical Capabilities of a State Network

Higher education has networking needs at three levels:

1. very high speed connections to external networks (e.g. Internet 2, NASA) and to other higher education institutions, nationally and internationally for the conduct of scientific research,
2. connection to campuses and satellite campuses within our respective university and college systems as well as among other Colorado higher education institutions, and
3. statewide connections between 4-year and 2-year campuses, K-12 schools, government agencies, medical and health education centers, distance education sites, etc.

Relative to the first level of networking, it is likely that the larger research universities will continue to maintain separate and distinct connections that support the advanced networking needs of the university's researchers with the Federal government and national projects.

At the second level, higher education must be able to utilize a network which reflects a contemporary, "state-of-the-practice" standard. It should be based on a high bandwidth ATM or SONET backbone capable of voice, video and data. It should allow for the statewide distribution of Internet and Internet2 without packets leaving Colorado. It should provide a model for video, including high speed (e.g. MPEG-2) video, traditional video (Picture Tel), and video over IP (H.323). A critical question is whether a state network will include voice transmission.

For Colorado's universities to be able to fully utilize a state network, it will be critical that it keep pace with emerging new standards, for example Quality of Service and multi casting. As these standards mature, they should be implemented in the state network. The need to operate within the current "state of the practice" may not be unique to higher education but typically higher education will need to operate within these standards before most other users. In addition, we need higher capacity sooner than most others, as we seem always to be pushing the leading edge of networking. Telemedicine applications will push our standards for the highest quality video available. Our research enterprises have other bandwidth needs to transfer files of extremely large research databases. The universities' national leadership role with regard to Internet 2 will rapidly lead to the next generation of real-time applications such as desktop video conferencing and classing, interactive, real-time collaboration, etc. Colorado's higher education institutions may be unique in that they already know how and what to do; what we need is raw capacity and

inter connectivity.

Higher education would like to encourage the MNT planners to consider how a network could provide statewide dial-in connections for higher education customers so that a student at any location in the state could make a modem connection to a network which would provide them access to any higher education institution at an affordable cost.

In terms of our future needs relative to a state telecommunications network, higher education's interests will be in the areas of high speed data, real-time interactivity with QoS (Quality of Service) and multicast, higher quality video (e.g. MPEG-2) for video classing, and voice replacement strategies.

Higher education would like to advocate for a state network designed as a set of layered services, with different entities getting services from different layers (and a single institution might get several different layers, depending on intended applications). The research universities, for example, would like high-speed SONET to the Denver MCI and SPRINT POPs, ATM circuits to other colleges and universities, and IP layered services to connect to K-12.

K-12 Networks

Access and Equity to Effective Instructional and Information Resources in the K-12 Environment Via Telecommunications Technologies

Eric Feder, Director, Educational Telecommunications Unit, Colorado Department of Education

"Your zip code should not dictate the quality of your education."

When the Colorado Telecommunications Advisory Commission wrote this in their December 1989 report to the Colorado General Assembly, they were expressing the widely held belief that regardless of where they lived, all Colorodans deserved and could benefit from a statewide telecommunications infrastructure connecting all Colorado schools. libraries, institutions of higher education and government offices with each other and the rest of the world providing access to local and remote instructional programs and information resources.

In the K-12 setting, telecommunications technologies, if used properly by trained practitioners and learners, can provide students, teachers, administrators and other staff members with resources to enhance their instructional and administrative programs. These technologies can help staff and learners overcome limited budgets, remote locations, time constraints, great distances, socioeconomic isolation, geography,, and other barriers to:

- provide educators and learners with *access to instructional and information resources* not otherwise available,
- help learners *improve their achievement* in a standards based curriculum, and
- provide learners and staff with tools to *improve their efficiency and effectiveness*.

Technology can help students and teachers succeed in a standards based curriculum. It can contribute to the development of schools where the walls between classrooms and the outside world have disappeared, where children are exposed to complex, real-world issues, challenged to sift through the raw materials of the Information Age, and empowered to communicate their ideas to a global audience. (Benton Foundation World Wide Web site). It can:

- Provide the flexibility to *meet the individual needs* and abilities of each student;
- *Reduce the risk of student failure* by providing alternative learning opportunities;

- Provide students with immediate *access to richer source* materials including primary source materials;
- Present *information in new, relevant ways* which help students understand, assimilate and use it more readily;
- *Motivate and stimulate* learning;
- *Enhance learning* for students with special needs;
- *Motivate* students to try out new ideas and take risks-.
- Encourage *analytical and divergent thinking*;
- *Encourage teachers* to take a fresh look at how teach and ways in which students learn;
- Help students learn when used in *well-designed, meaningful tasks and activities;* and
- Offer potential for *effective group work across distances.* (the National Council For Educational Technology - Australia (NCET) 1994)

Interactive technologies (including the Internet / Videoconferencing can provide opportunities to "individualize the educational experience to accommodate the needs, interests, proclivities, current knowledge, and learning styles of each particular student." (*Report to the President on the Use of Technology to Strengthen K-12 Education in the United States*. President's Committee of Advisory on Science and Technology, Panel on Educational Technology. March 1997).

Telecommunications technologies can equalize the playing field for all learners regardless of their race, religion, ethnicity, gender, disability, age or place of residence. It can help provide them with access to instructional courses, staff development programs. information resources and subject experts by overcoming the barriers of time, distance and/or geography. No longer must learners who are geographically or socio-economically isolated settle for second best.

Interactive telecommunications technologies (including the Internet and videoconferencing) enable remote learners to take courses, conduct research and share resources with their peers and subject matter experts in their local communities or communities of interest.

- Learners in Flagler, Wiggins, Hayden, Lyons and Denver or in any of the over 65 other Colorado communities where their schools are connected to satellite downlinks or interactive video networks can take advanced or other high-interest/low enrollment courses. These instructional courses, staff development programs and information resources, and those made available via the Internet, provide learners of all abilities with the opportunity to explore and excel in areas in which they could never have found challenging courses or course materials. Programs delivered by remote distance learning course providers, neighboring schools and regional and distant institutions of higher

education enable man-, high school students to graduate with a high school diploma and either a majority of the courses needed or a full associates degree from a community, college under the post-secondary options act. (East Central BOCES - Fifth Year Program);

- Community members take college courses and participate in training, certification and information programs without leaving their communities (Deer Trail and other schools on local interactive video networks);
- Clusters of school districts, by working together, provide learning opportunities that they could not provide to their students and teachers independently (multiple Colorado distance learning networks provide courses and staff development programs).
- Students, who may not have done well elsewhere, succeed in classes as members of an electronic, virtual high school. The Monte Vista On-line Academy provides forty high school students, many of whom are at risk, with an environment that meets their learning styles, schedules, interests or other circumstances. This program is so successful that they will increase enrollment to 60 learners during the 1998-99 school year.
- Teachers and administrators use telecommunications technologies (e-mail, the world wide web, etc.) to communicate with colleagues and subject matter experts. (e.g.: *Genetic Engineering via Telecommunications* is a course that has been delivered via the Internet from -Air Academy High School to hundreds of students and teachers in over 50 high schools during its five years of delivery. This course links Colorado teachers, learners and experts from across the country.
- Learners of all ages can access remote information resources via the Access Colorado Library Information Network (ACLIN).
- Information can and will be purchased and stored in more cost effective and accessible ways depending upon local needs and the price and characteristics of the resource itself. Some information resources will be classroom specific. Others will be accessible throughout the school via local area networks (LANs) while still others will be purchased at the district level and made available to multiple schools throughout the district via their wide area networks (WANs). Some very expensive or limited use resources may even be purchased regionally or by a single Colorado entity with access provided to all districts and libraries in the region or across the state via the Internet or a statewide multi-use network. This will increase the number of information resources available to teachers, students and community members. (Nancy Robbins, Mesa School District 51)
- Teachers with like interests can participate in cooperative planning activities across great distances or with the teacher in the next classroom with whom they have difficulty meeting because of conflicting schedules (Nederland Elementary School, Boulder Valley

School District) while administrators can "meet" to discuss common problems or share information.

- Students use the Internet (primarily e-mail and the world wide web) and other technologies to demonstrate mastery of content standards. They conduct research accessing local and remote information resources, store data and other information, create documents and other projects and publish and otherwise disseminate these materials to their teachers, community members, their peers, other researchers, and college and university students interested in becoming teachers. By publishing their projects beyond the classroom, learners collaboratively develop information resources, improving the quality of the writing. (Benton Foundation World Wide Web site)
- Schools participate in partnerships with community or distant businesses to provide their students with unique learning opportunities that would not otherwise be available. ('e.g.: HP Mentor Program)

Telecommunications networks can provide school districts, schools, administrators, teachers and other staff with multiple opportunities to increase efficiencies. According to John Ackelson, Director of Information Management, Adams County School District Twelve and chair of the Colorado Information Processing Association (IPA) information technologies -" and telecommunications networks greatly increases the effectiveness of data collection, information processing and data reporting.

- The ability to collect, store, access, analyze and distribute fiscal and student data to meet specific and ever changing information needs provides administrators and others with the information needed to make informed decisions.
- Personnel resources formerly allocated to the collection and processing of data are being redirected to provide support for the international program
- With full implementation of the automated data exchange, state data needs will be met in a fraction of the time because data will be transmitted via standardized formats in a more accurate and useable mode.
- According to the Data Analysis/Feasibility) Study (CTMG), school districts reported that they would benefit from an estimated average annual savings of $3190. Through data collection at the record level nearly 50% of the CDE forms could be eliminated and many others could be drastically reduced in size. Further, electronic access for analysis to the summary data collected by CDE will benefit 81 % of Colorado school districts.
  The demands for student achievement data will increase as the state continues to move toward measuring against the model content standards. The collection of this data from school to district and district to state with a minimum of handling can increase access without overly burdening staff.

Additionally, the use of other business applications can greatly reduce the amount of time and effort required to accomplish current and future tasks.

- The, automation of food service functions can facilitate all areas from charging students and teachers for their daily lunches to maintaining food and supply inventories and from balancing daily accounts and sending this information to the district business office to maintaining employee attendance records.
- Providing school and other district personnel with the ability to initiate and process purchase requisitions on-line can greatly decrease the time it takes to process orders and the paperwork and staff needed to accomplish this. Once this ordering information is in the system, orders can be electronically sent to the district warehouse and contractors further decreasing delays and costs.
- Enabling school and district personnel to access contract information on-line will further cut delays and costs in the ordering process in addition to providing more accurate and timely information to staff (State of Colorado)
- The posting of bid solicitations on-line provides vendors with more timely access to the procurement process providing quality goods at lower prices. (State of Colorado)
- E-mail can reduce the amount of time needed to contact individuals in the school district, community or throughout the state. nation and world. Ibis improved communications can improve access to information and enhance operations.
- Videoconferencing can reduce the need to travel within the district and to distant meetings saving travel costs and time.

Telecommunications technologies and local. regional and statewide networks connected to the Internet for national and worldwide communications can enhance the instructional programs and administrative functions of all Colorado schools by increasing student achievement, access to information and human resources, and productivity.

Library Networks

Authored By: Jerry McCarthy, February, 1998

Library networking in Colorado dates from the mid 1980's when a group of research libraries banded together to create an electronic catalog program and link their resources together. The group, which had been created in the 70's to share resources, was called "CARL," the Colorado Alliance of Research Libraries, and their effort led to the development of the CARL system, a library automation product which enabled Colorado residents in the front range to have free, dial-up access to 10 higher education and public library research resources, while providing the libraries a common catalog interface and easy patron and professional access to each other's resources. In the late 1980's, the CARL software system was used to create MARMOT, a library catalog system which provided consolidated access to library catalogs for a consortium of academic, school, and public libraries on Colorado's western slope, serving clients from Craig to Cortez.

On a smaller scale, many Colorado public library systems, such as Jefferson County Public Library, also developed network capability in the 80's to link multiple branch sites with a common service center or main library using library catalog/automation systems from a variety of vendors.

In 1992, the Colorado State Library created the Access Colorado & Library Information Network (ACLIN) to link all (participating) automated library catalog systems in the State and to make them accessible via no-cost local or 800 line dial-up to everyone in Colorado. ACLIN provides free dial-up access (text only) to almost every automated library catalog in the State (and a large number of databases and Internet-based information resources (more than 230 in all). Since ACLIN is Internet-based, its resources are also available, in a fully graphical interface, to Colorado residents who have personal dial-up accounts or other access to the Internet.

In the 90's the growing popularity and accessibility of Internet technology accelerated development of networked library resources in Colorado. In 1995, the Three Rivers and Pathfinder library systems in western Colorado joined forces to create their own Internet service provider (ISP), called Tripath Network, providing twenty-one 56K links for schools and libraries (and dial-up users at 9 sites) to a shared T-1 line in Grand Junction.

Colorado is one of the leading states in the country for statewide networking of library resources. Recent state and national surveys indicate that 73% of Colorado public libraries provide Internet access to their patrons ("*Coloradans--and Colorado Public Libraries--Top National Internet Norms*"; FAST FACTS, ED3/110.10/136).

In the past three years ACLIN has attracted more than $3 million dollars in federal technology grants and library support funds which have been invested in content, technology, and network development for Colorado libraries. In 1997, ACLIN distributed federal grant funds to provide dedicated Internet connections of 56K or higher to 23 Public Libraries, and funded full-graphical dial-up access to the Internet for 62 school or public libraries and multiple dial-up lines for two communities (Craig and Grand Junction). Also with federal grant funds, ACLIN has provided demonstration grants for cost-saving wireless linkages between main and branch libraries, funded a half-dozen library Internet link upgrades to T-1 bandwidth at a half-dozen public and community college libraries. In 1996, ACLIN distributed more than 150 modem-equipped PCs to libraries, community centers, and other public sites for access to its 800 line service from the most rural areas of the state.

ACLIN has not been alone in attracting grant funding for telecommunications projects. In the same period (1994-1997) another two million dollars in grant funding for technology, content, and telecommunications development was awarded to Colorado library and museum organizations. Several libraries participated in SB96-197 projects to receive Internet connectivity, funding for training and public programs, and other advanced technology resources.

In 1998 libraries are eligible to receive discounted (subsidized) access to telecommunications services through a program for Schools, Libraries, and Health Care organizations administered from the FCC High Cost Fund. To date (February, 1998) 81 libraries and library service organizations have filed technology plans as part of the application process for this funding. These discounts which for libraries and schools are based on the percentage of students who are eligible for school lunch programs in the community (a measure of poverty), can provide up to a 90% discount on telecommunications services for libraries.

This very active library network community and ACLIN provide a context for statewide information delivery and access that has facilitated statewide resource sharing among libraries, making it possible for even Colorado's smallest public libraries, for example, to join a statewide contract for access to full-text information resources online (magazine articles, etc.) for as little as $200 per year. Before ACLIN, such access and participation was not possible.

In addition to library catalogs, the ongoing operation and development of ACLIN services has supported increased access to shared resources such as historic photo collections and museum exhibits; a very popular collection of Colorado health information resources; an "ACLIN for Kids" page of resources for parents and kids about reading; business development resources; and more.

On a very practical level, Colorado library networking means that residents anywhere in the state can have access to the best of the State's library resources at their local library or school, through a personal Internet connection, or through ACLIN's free dial-up service if they have any modem-equipped personal computer. This is particularly valuable for students at all levels of the educational system, for educational institutions stretching their resource dollars, for the lifelong learning of adult students, for anyone in the state research new business development, for senior citizens, and (not least) for all Coloradans who take pleasure in reading.

Improvement of Colorado's Telecommunications Infrastructure via the ANAPs proposed by the MNT will benefit all libraries in the State, particularly those in rural areas.

Health Care Networks

Authored By: Jerry McCarthy, February, 1998

Introduction

The use of advanced telecommunication services for health care in Colorado is evident in several demonstrated clinical, educational, and business applications available from a number of health care institutions and network organizations around the State. The high costs of dedicated network services and the lack of reimbursement for telemedicine services, however, continue to limit TeleHealth services. Two recent positive developments, however, may begin to alleviate these two problems and help grow telemedicine services into a practical line of service for the business of health care in Colorado. The first is the impact of Health Care provider access to so called "e-rate" FCC High Cost Funds which will reduce (via subsidy) the line costs of health care providers to rates that are comparable to those available in the nearest community of 25,000 population. This subsidy also extends to Internet account subsidies of up to $180 per month for health care professionals who do not have local dial-up access to an Internet provider. The second positive development is the start in January of 1999 of limited reimbursement from Medicare for telemedicine services provided in areas of Colorado defined as "Health Professional Shortage Areas" or HPSAs. A HPSA area is a geographic region with a physician to population ratio of greater than 1:3500 (see following map for Colorado HPSA) or 1:3000 in areas of "unusually high need" which is defined by one of the following criteria:

- poverty population greater than 20%
- birth rate higher than 100 births per 1000 women age 15-44
- more than 20 infant deaths per 1000 live births

These limited Medicare payments however will still consist of only one clinical visit or professional consultation payment which may have to be split between the two consulting providers and Medicare will not reimburse *any* telecommunications or other non-clinical costs. Even so, the high cost fund subsidy and Medicare reimbursement combined may spur more clinical consultation via telemedicine in the next two years, although the business case for telemedicine is still somewhat weak, pending resolution of reimbursement issues.

Major Programs, 1997

There are several well-established telemedicine efforts in Colorado, and an unknown but rapidly increasing number of sites and practitioners who link to clinical services and educational/reference resources and programs through the Internet, to which Colorado is among the leading western states in providing access. The Colorado AHEC Program, for example, operates the Mountain and Plains Partnership (MAPP) a regional educational system for Nurse Practitioners, Certified Nurse-Midwives and Physician Assistants over the Internet, providing interactive PC video/computer instruction to approximately 100 "TeleLearning Center"-equipped sites.

The University of Colorado Health Sciences Center (UCHSC/UH) is participating in a TeleHealth/TeleEducation Consortium of 18 hospitals: HealthCare Colorado. The UCHSC/UH's own network has dedicated links to four hospitals in Denver: Children's Hospital, Denver Health Medical Center, National Jewish Medical Center, and AMC Cancer Research. Additionally, they have a dedicated link to the High Plains Rural Health Network which extends their connectivity to all of the hospitals on the High Plains Network. The UCHSC/UH Network also has connections to all of the other CU campuses and numerous affiliate sites in the metropolitan area and links to hospitals in Alamosa, Cortez, Grand Junction, Trinidad, and Durango.

UCHSC also provides services to six AHEC teleconference sites (Alamosa, Clifton, Cortez, Craig, Greeley, Montrose, and Pueblo) and to numerous sites including most of the junior colleges throughout the state on the State's CIVICS and CCCOES Networks. The UCHSC/UH, in conjunction with the Denver Health Medical Center, managed a telemedicine program to serve the State Correctional Facilities, with a current active program at the Limon facility. They expect to expand these services to other correctional facilities throughout the State in 1998.

In addition to its provision of telemedicine services to the Colorado Department of Corrections site at Limon, Denver Health Medical Center recently installed a telemedicine link to Routt Memorial Hospital in Steamboat Springs. This connection links both the emergency room and operating room at Routt Memorial to Denver Health's Level I trauma center consulting expertise.

Columbia- Presbyterian/St. Lukes has a telemedicine site but recently withdrew from membership in the High Plains Rural Health Network.

Kaiser Permanente operates a network of 15 clinical sites and 5 business office sites for clinical consults, staff and patient education, and business teleconferencing.

The High Plains Rural Health Network (HPRHN), based in Fort Morgan, Colorado, includes in its membership 18 hospitals, three clinics, and two CIVICs partner sites primarily located in the North East and High Plains of Colorado (with links to 3 sites located in Nebraska and Kansas). HPRHN provides interactive video conferencing to deliver specialty health care and continuing education. The system also supports a rural residency program between Greeley and Wray, Colorado.

Centura Health, the result of a merger between Adventist Health System and Sisters of Charity, operates Centura Health Network (CTN), a telemedicine network linking 20 clinical sites in Colorado: nine rural hospitals, three rural clinics, four urban tertiary hospitals, and four urban primary/secondary hospitals. CTN provides clinical telemedicine services in a variety of specialty areas and is also used for distance education, administrative meetings, tumor boards, and other healthcare conferences.

There is also at least one site which is managed by a proprietary service provider. An out-of-state, commercial vendor, Medical Development International of Chantilly, Virginia, operates two correctional telemedicine sites for Arapahoe County, Colorado.

APPENDIX C

Aggregated Network Access Points

Overview

The MNT has recommended seventy-five (75) ANAPs based on the analysis of services, and needs of the state. This analysis focused on the aggregation of circuits into a shared, multi-use backbone providing greater bandwidth and capability than individual circuits are able to provide. For planning purposes, an ANAP is used to measure carrier service levels and the availability of telecommunication circuits in a surrounding geographic area. Also included are their anticipated short-term growth needs and the potential participation of the private sector.

The term "Aggregated Network Access Point" was coined for this report to reflect a significant difference from an earlier, more familiar term, "Point of Presence" (POP). A POP is generally used to describe the location of some level of telecommunications access capability in a geographic area. An ANAP defines a geographic area, describing the aggregation of existing traffic, anticipated short-term growth needs. An ANAP is scaleable to permit the potential investment and participation of other public/non-profit users. By aggregating technology investment in communities, the ANAP concept provides a better business case to bring higher levels of technology to all users in the community.

Conceptually, ANAPs provide a basis for ensuring equity of access to advanced technology services throughout the state. This can be done via private/public partnership between the telecommunications providers and the State. Cost efficiencies realized in the more developed areas of the State can be reinvested in technology access in less developed areas of the State to achieve the goal of equitable access.

For vendors, there is the additional benefit of dealing with fewer, larger clients and a corresponding saving in marketing costs, as well as the potential for more rapid diffusion of advanced technology in the newly aggregated local market. State government, taking the lead in this investment, provides "anchor tenant" attraction and access to technology for local government and businesses. This provides benefit to local service and economic development efforts.

The MNT recognized the need for two levels of service, differentiated not by technology, but bandwidth required meeting the needs of an area. Therefore, the MNT designated seven sites for super ANAP status. These sites were chosen based on an anticipated need for high capacity data, enhanced video services or the projected deployment of Internet II.

Appendix E contains a list of maps designating the ANAP sites. The maps depict the State of Colorado with the ANAP sites noted and classified. The other map demonstrates the location of potential sites that will be connected to the network.

Appendix E also includes the current ANAP Circuit Detail. It is a summarized listing from the database being developed for the MNT process. This listing represents a point in time inventory of the circuits used by state government to serve the ANAP city.

Detail

This appendix is an outline of the methodology used to analyze the required ANAP functionality and capability. The detail included in this section is the first iteration of this analysis. It is apparent from the subsequent information that the information is not complete, and the reader is cautioned about making conclusions until more information is available.

Each ANAP will have the capability to handle data, video and voice services. This level of service mandates the use of high bandwidth, advances services. This plan recommends the use of ATM service operating over fiber optic facilities to provide adequate levels of service.

Process

The MNT has defined a process used to conceive and refine the ideas and concepts developed through the analysis process. Presented below is a brief description of this process.

Create a Database

The first task was to create a database that contains all State of Colorado circuit information. This database served as an analysis tool for aggregating circuit information such as bandwidth and cost. The database also provided CITS Telecommunications Services with a circuit directory

to aid in planning and the diagnosis of problems. The schema or listing of data elements for this database is presented below.

The database can also be used to present data from local consortia and other groups that have an interest in this project. The Multi-use Network Team encourages these groups to integrate their data for comprehensive regional studies.

Requested Data Elements for the Statewide Network Project

The following is a list of the data elements required to assist in the development of a statewide inventory of telecommunications circuits in use by the Departments and Agencies of the state.

- State Network ID

  The State Network ID is an attribute that is created and used by the CITS Telecommunications Services to identify billing information for circuits by State Departments and Agencies. A unique State ID is assigned to each unique circuit (defined as end to end). A State Network ID may contain multiple carrier circuits connected to form one end to end circuit. This field is optional for non-GSS supported networks, but is helpful to group individual carrier circuits into one end to end entity.

- Segment Code

  The Segment Code is an attribute that is created and used by the CITS Telecommunications Services to identify the different segments of each State Network ID. This field is optional for non-CITS supported networks.

- Termination Point Code

  The Termination Point Code is an attribute that is created and used by the CITS Telecommunications Services to identify the different leg of each state network segment. This field is optional for non-GSS supported networks.

•Telco ID

The Telco ID is an attribute that is created and used by different commercial providers to identify their circuits. A state used circuit may not have a Telco ID if it is internally provided by a state agency. Where a TelcoID is provided by a commercial vendor, it should not be confused with the billing number, also sometimes known as the K-Number. An example of a USWest Telco ID is 29FDDA123456.

• Circuit Provider

The Circuit Provider is the name of the business or organization that provides, and probably bills, for a circuit. There is a very broad range of circuit providers in the state. Commonly known ones include USWest, MCI, AT&T, etc.

• Circuit Capacity

The Circuit Capacity is the bandwidth of the circuit measured in bits per second (bps). Commonly used Circuit Capacities are 9600bps, 2400bps, etc. For T-1 or DS-1 circuits please report the capacity as bits per second (T-1 is 1.544 Mbps). This is less critical for analog service, whose capacity is dictated by the modems.

• Billing Number

The Billing Number is usually associated with commercially provided circuits. It is also sometimes known as the K-Number. It may or may not correspond to the TelcoID field depending on the billing practice of the provider. In USWest circuits, it consists of the valid telephone number for the slot taken at their switch (i.e. 303-233-7291).

• Circuit Status

The Circuit Status is an attribute created by CITS Telecommunications Services to identify whether a circuit is in active use. For other Agencies it is assumed that all circuits reported are in active use unless otherwise identified.

• Monthly Cost

The Monthly Cost attribute is the identified cost of a circuit, on a monthly basis. For circuits provided by commercial vendors this will correspond to the monthly billing rate. For internally provided circuits this will consist of the annual cost divided by twelve.

- From and To Information

For purposes of this project, circuits are being identified as uni-directional (i.e. as going from somewhere, to some place else). An example of this is a circuit that goes from CITS DATA CENTER at 690 Kipling in Lakewood, to Telecommunications Services site at 2452 West Second Ave., in Denver. Although the circuit passes through the USWest switched network, we are only interested in the two primary termination points.

In the example, the From Agency is CITS DATA CENTER, the From Street is 690 Kipling, the From City is Denver. The To Agency is CITS Telecommunications Services, the To Street is 2452 West Second Ave, the To City is Denver. The From/To Contact Name and Phone is the person(s) with knowledge of the circuit or service. A site may have many circuits coming into it. It may even have many circuits that come into it from the same source (i.e. the 2452 West Second Ave. may have two 9600bps circuits coming from CITS DATA CENTER). We are looking for information on EACH circuit, so in this case we would identify two distinct circuits.

Gather information about upcoming projects

Information was assembled about pending projects affecting telecommunications in each of the ANAP areas. This included state projects, local initiatives, projects and other activities that affect the region. The data that is gathered from these projects will serve as the basis to project the aggregation levels for any ANAP. It is important to note that the MNT has begun to gather and analyze the information, and that it will be added at a latter date. The MNT has gathered information about such projects as the Human Services Children Youth and Family, Colorado Benefit Management System and other state projects.

Establish Cost Models

All information was used for analysis to provide educated estimates on the magnitude of the cost of this network. It should be noted that this activity *is not a detailed network design*. It is used as a methodology to determine system-wide impact on costs. This is accomplished by supplying the model with as much detail as possible. By calculating through a prescribed sequence, the model can predict costs based on the information provided. The cost model has been used for several

iterations of cost estimation, and it will continue to be refined for accuracy and utility. This is where information from local groups is vital to the progress of this project

The team had to make some assumptions based on knowledge gathered at the time. This paragraph is provided to explain the methodology used for cost estimation. The components of the cost model are based on product and service pricing from vendors, tariffs and installation costs from carriers and estimated costs based on past experience for site preparation and some other components.

Assumptions

1. The cost model assumes that the network will be built by private industry, and that minimal labor by state forces will be required other than project management and coordination of resources. Therefore, personal services are kept to a minimal amount. The cost model was based on tariffed services supplied by carriers.

2. The cost of providing video services was also estimated as a lump sum cost. The technology used to provide video services was not clearly specified, so several technical models were considered. The cost model reflects an educated estimate of cost of the technology to be used, but may not be accurate in this category.

3. The bandwidth estimated for their consideration and cost calculations were based on point in time service levels. The actual cost of this service may vary due to growth, unanticipated demand or other parameters effecting the size and constitution of this network.

4. Specific sites within the ANAP cities were not provided to carriers, so the actual costs of delivering the services to the specific locations were not provided. The MNT had to estimate costs for these components based on previous experiences.

5. The model assumes that carriers will receive adequate incentive from state aggregation to make local investments in the infrastructure. This aggregation may still not provide an adequate business case for investments.

6. Following one of the recommendations of the MNT, the model assumes that all state agencies would use the multi-use network. This affects the cost model because of volume buying discounts and aggregation of efforts.

APPENDIX D

Other States

Introduction

As part of the assessment process, the MNT Team looked at how other states are handling their telecommunications infrastructure. The following is a summary of the state of their infrastructure. More detailed information is available in the MNT library. The states chosen are either from our region of the United States or had approached the infrastructure issue from an interesting or unique prospective.

Individual State Summaries

Arizona

An effort to integrate the existing state networks (approx. 18) was lead by the Telecommunication Policy Office, Office of the Governor. The goal was to implement an ATM network to support government agencies and distance learning for higher education, paid for from monies in the State's general fund. Estimated cost, including missing mile, was $200 - $250 million over 7 years. The project had progressed to the point of issuing an RFP, which yielded only two respondents. Neither respondent adequately addressed the RFP. No award was made. The effort was stopped by the Office of the Governor and was being reviewed.

Unofficial assessments indicated the project had problems from the beginning. Inadequate work was done to identify stakeholders, rural areas were not addressed, requirements were heavily skewed by higher education needs and their desire for postalized rates. Non-bidding vendors identified the procurement process as a major impediment as it did not permit discussion or negotiations once the RFP was released.

Iowa

The Iowa Communications Network (ICN, also known as the Iowa Educational Telecommunications Network) is a state-owned 3,000-mile fiber optic network created to connect all counties with data, voice, and video services. The network maintains 129 video sites in school districts, libraries, and government offices across the state. Although the system is designed to serve the administrative needs of state government and to provide services to public and private educational users, it is mainly used for educational purposes which has the highest network priority. The ICN is overseen by the Iowa Telecommunications and Technology Commission, the Educational Telecommunications Council, and 15 regional telecommunications councils.

A total of $114,530,000 in Certificates of Participation (CP) were issued in 1992 and 1993, of which $88,762,321 was used to build the first two parts of the ICN. Semi-annual interest and principal payments are paid from interest earned on investments related to the CPs. Insufficient earnings have created an annual shortfall of approx. $12,500,000 which is paid for via appropriation from the State's General Fund.

Implementation of Part III of the ICN began in July 1995 at an estimated cost of $94,600,000, ending June 1999. An average annual appropriation of $23 million from the Rebuild Iowa Infrastructure Fund will pay for this effort.

Ongoing operations are paid from fees charged for services provided. Insufficient revenues have created an average annual short fall of $2,400,000 which is paid for via appropriation from the State's General Fund.

Kansas

The Information Network of Kansas (INK) was created in 1990 with the passage of Senate Bill 678. The intent is to provide equal electronic access to state, county, local and other public information to the people of Kansas. The INK board of directors, appointed by the Governor, met in November 1990 to draft policies providing the framework for the network. After a ten month competitive bidding process, the Kansas Information Consortium (KIC) was hired to manage the network.

INK sets policies, approves areas of activity and contracts, and regulates pricing for the network. KIC furnishes the capital and staff necessary to develop and operate the network, for which it receives a regulated return. The majority of the revenues are remitted to the State.

INK is unique in that it is a model for public/private cooperation, winning the Exemplary Award for Significant Innovation and Achievement presented by the National Center for Public Productivity. To facilitate the mission of INK the Kansas Legislature mandated that "All state agencies shall cooperate with INK in providing such assistance as may be requested for the achievement of its purpose. Agencies may recover actual costs incurred by providing such assistance. Services and information to be provided by any agency shall be specified pursuant to contract between INK and such agency." Currently Nebraska, Indiana, and Arkansas are implementing similar models.

The majority of services available on INK are free of charge to anyone on the Internet. No State funds were used in its creation or operation. It is entirely funded by the fees generated under the premium service. The premium service contains legal, banking, and other specific business applications that have a fee associated with access.

Minnesota

Minnesota Net (MNet), Minnesota's state government network, was created in 1989 to provide voice, data, video, and other telecommunications transmission services to schools, libraries, public corporations, and federal, state, and local government agencies, selling its services at cost. The backbone network uses a fiber optic network called Minnesota Equal Access Network (MEANs), which was developed and is owned by a consortium of 60 telephone companies. The Minnesota Regional Network provides MEANs with Internet access. MNet provides video conferencing services at about 25 sites for state, county, and local governments, public and private universities, and some public schools. The legislature has experimented with holding some hearings over Mnet. Access Minnesota extends MNet to Minnesota's educational community and, to a lesser

degree, to state citizens. Public access terminals will be located in county extension offices.

Nebraska

Nebraska's telecommunications network consists of fiber optic cables connecting all 93 counties with digital technology, providing access to advanced telecommunications services to 99% of the state's population. The legislature created the Nebraska Information Technology Commission to develop a statewide strategy to ensure that the telecommunications infrastructure needed was planned, coordinated, and implemented in a timely fashion.

Nebraska deregulated its telecommunications market in 1987 which is probably one of the reasons why the state succeeded in building an extensive, sophisticated telecommunications access system. State government is the largest consumer of telecommunications services, allowing it to leverage market share to create the incentives for private telecommunications companies to invest in. State service contracts help providers recover costs by agreeing to contracts of up to ten years, demonstrating commitment to supporting private sector development.

The Rural Development Commission and the State Public Library System joined in 1992 to create Nebraska Online (NEON), a statewide information distribution network modeled on the Information Network of Kansas (INK). Initially free of charge to any citizen via a toll-free number, subscription revenues now cover the expansion and operation costs of the network, as well as the cost of a toll-free access number. Subscribers receive electronic access to many state government agencies and services, as well as email, library catalogs, and a link to the Internet. More than 7,000 Nebraskans use the service each month.

Nebraska's local exchange carriers, working with the Division of Communications of the Department of Administrative Services, have developed statewide frame relay network technology. This allows data to be carried at high speed but low cost among state agencies and local networks across the state.

Educational telecommunications programs are delivered by the Neb*Sat satellite system. Neb*Sat carries a number of signals simultaneously among Nebraska's schools, government, and educational administrative offices. The Nebraska Educational Television Network (NETV) uses Neb*Sat to provide informational and distance learning programming to K-12 schools statewide.

The State Division of Communications operates the Nebraska Videoconference Network at 14 sites providing two-way video and audio facilities for use by both the public and private sectors. The initial construction cost of about $1.5 million is being recovered by user charges.

North Carolina

The North Carolina Integrated Information Network (NCIIN) was built in 1994 by GTE, Bell South, Sprint, AT&T (who now owns it). Before construction, the state agreed to purchase a major share of the capacity of the network. The state appropriated $7 million in FY 1995 and $2.5 million in FY 1996. Initially 74 sites were served by NCIIN, currently there are 80 sites. NCIIN has been open to private firms since 1995.

The system was designed to be self-contained forcing users who wish to connect to the Internet to purchase additional hardware and once connected users could not take advantage of the network's huge data transfer capacity. The numbers of users, who have signed on, including government agencies, are below expectations. Many have chosen lower-tech, cheaper alternatives. NCIIH sites cost between $70,000 - $100,000 to set up and slightly more than $3,000 per month to service.

Ohio

Implemented a leased fiber backbone integrated with an 800 MHz radio system for public safety and emergency management, called **Ohio SONET**. It aggregates the state's voice, video, and data and replaces the existing microwave system. Initial funding was provided in FY 1994-95. The system is intended to interconnect the following.

- 54 public television and radio stations.
- 250 public libraries, **OPLIN**: Ohio Public Library Information Network.

- 3,600 public schools, **SchoolNet.**
- 100 college and universities.
- 100 state agencies, **SOMAC**: State of Ohio Multi-Agency Communication.
- State's centrex phone system.
- State lottery.

Estimated annual savings (based on current usage) will be more than $12 million. Ohio has experienced the following benefits to date.

- $20 million cost avoidance by not replacing the state's aging microwave system.
- $50 million less in capital expenditure by not building a stand-alone radio communications system for public safety and emergency management. Operating a stand-alone system would have cost $1 million more than current expenditures.
- Universities and agencies are paying approx. $1,000 per month less for each line.
- The cost of a T1 line on state contract dropped to $1/4^{th}$ the cost of a commercially-purchased line. The result was the ability to acquire more robust communications capability at the end-user level.

Oregon

As a result of recommendations made by the Oregon Telecommunications Forum (a working group appointed by the governor) and subsequent legislative action (SB 994) an effort to "coordinate the consolidation and operation of all telecommunications systems used by the state and state agencies" was begun. The Department of Administrative Services was charged with the responsibility to accomplish the goal.

This is part of a larger effort covered by the Telecommunications Work Plan for Oregon published June 1997. The plan is based on a vision for telecommunications that states;

"To improve the quality of life and economic development in Oregon communities by enhancing the delivery of education, health care and government services, and supporting the further development of business through:

1. Affordable telecommunications solutions for every Oregon community, and
2. Training and support necessary to effectively utilize telecommunications."

To fulfill the vision six strategies, and associated tactics, were identified:

1. Outreach, Education, Technical Assistance and Funding for under-served communities
    - Creation of statewide resources that will serve to coordinate the delivery of outreach, education, technical services and project funding
    - Maintenance and enhancement of a clearinghouse and toolkit

2. Aggregation of Demand
    - Formation of strategic partnerships and purchasing collaborative
    - Requirement that vendors show the location of switches and fiber as part of all future contracts
    - Creation of incentives for telecommunications providers to file tariffs/price lists in areas where a frame relay switch exists due to state contracts
    - Establishment of an ongoing process that supports the mobilization of both geographically-based and interest-based communities

3. Incentives and Funding
    - Leveraging the state and local rights of way
    - Identification, analysis and development of legislation to create financial incentives and/or subsidies to encourage private investment in infrastructure
    - Funding for locally-based pilot/demonstration projects

4. Leadership and Ongoing, Integrated Planning and Organizing
    - Continued expansion of collaborations among key communities of interest
    - Continued expansion of the involvement of a diverse spectrum of telecommunications service providers in planning initiatives
    - Establishment of an Innovation Team to review, analyze and advance new solutions for affordability and accessibility
    - Establish a role for the forum to frame critical perspectives for analysis and recommendations to the Governor
    - Creation of awareness of the critical role of telecommunications among state leadership

5. Consolidation of Government Networks
    - Confederation of government networks
    - Coordination of internal efforts to share and coordinate data
    - Design of state and local telecommunications integration and demand aggregation into projects
    - Creation of a structure for leveraging state and local partnerships

6. Legislative and Regulatory Action
    - Regulatory and legislative actions that encourage private investment in infrastructure in under-served communities
    - Regulatory and legislative actions that will enhance access to and ability to use telecommunications
    - Regulatory and legislative action that will foster collaboration, consolidation and interoperability among government networks and facilitate public access to government information

Pennsylvania

Recently completed an information technology strategic planning initiative that covers telecommunications. The state operates a high-speed fiber-optic network referred to as MAN, Metropolitan Area Network. The network, which replaced a previous network called SNA Core, connects state agencies located in the capitol region. The state is

pursuing a comprehensive effort to acquire telecommunications services, systems, and infrastructure known as The Pennsylvania State Government Telecommunications Acquisition Project. The effort is headed by the Office for Information Technology. Several working groups were formed to address issues and make recommendations. A report was released late January 1998 and is currently available for public comment.

Texas

The state is in the process of re-engineering the statewide telecommunications network and renewing the services to support the network. The needs of the state have grown and changed since the last network. The 1997 State Strategic Plan for Information Resources Management (SSP/IRM) indicated that a coordinated communications infrastructure is necessary to leverage interagency endeavors and to provide services in an efficient manner.

The first State Network Plan (1991) help set direction for the replacement of the TEX-AN II network contracts and services. The goal was the development of a unified state network, based on open standards and concepts. The first step in this process was completed with the award of the TEX-AN III contract for services and the development of the Capitol FDDI ring that provided for the inter-exchange of information.

The Texas Telecommunications Strategic Plan of 1994 took a broader view of the state clientele to include local government and citizen access. The goal was to promote a telecommunications infrastructure providing statewide broadband, switched services at reasonable costs, not only to state government, but to local entities and the public as well. Since then the legislature has deregulated the state local exchange environment, made funding available for schools and libraries, and agencies have moved towards enhanced infrastructures, including extensive use of the Internet.

The existing network (TEX-AN III) is a multi-node hybrid network utilizing digital facilities on the backbone and within each Local Access and Transport Area (LATA). All inter-LATA network circuits are routed over fiber provided by Inter-exchange Carriers. Network presence is provided in all seventeen LATA's in the state. Primary

switching hubs are strategically located in eight LATAs and all LATAs are served by Newbridge DS3 digital multiplexers (Transmission Resources Managers or TRM's). Multiple nodes are configured to accommodate network traffic requirements and to provide alternate routing and disaster recovery capabilities. Users are able to access the network for voice services through either virtual or dedicated. Dedicated facilities are available for data and video requirements from sub-DS0 up to and including DS3 operating speeds. Management of network resources is provided through the central network management system of the Newbridge TRM's. The network management system provides network-wide reporting and proactive maintenance.

The merging of the TEX-AN statewide routed data network with CAPnet consolidated the state government access to Internet service providers (ISP). Additionally, the tremendous growth of Internet requirements for public school districts, public libraries, and not-for-profit hospitals has led to a need for DS3 access to the Internet.

TEX-AN has provided video services over the network. Hearings with prisoners require continuous presence video monitoring and a four-way split screen to be preserved as a permanent record. The state contracted with Southwestern Bell for multipoint video services (MVS) to enable the interconnecting of video networks throughout the state

TEX-AN III has reached the limits of the economies of scale available through the T1 and DS3 technology. Bandwidth requirements continue to grow, especially for data and video applications. The existing network design will not permit upgrading to higher capacity services such as SONET. Contracts for TEX-AN III equipment and services expire in August 1998. The growth in network traffic and requirements indicate an immediate need to begin the design and implementation of TEX-AN IV.

Utah

Technology 2000 is Utah's initiative to implement an electronic highway to inter-connect electronic devices into a single network of computers, telephones, televisions, and other electronic devices. This will enable the transmission of digitized data, full motion video, voice, and still video images.

The Utah Telecommunications Coordinating Committee (UTCC), with representation from Information Technology Services (ITS), the Utah Education Network (UEN), the Courts, the CIO's office and local government has been formed and charged with the task of developing the optimum network for government in the State of Utah. The approach is to integrate a set of distributed networks coordinated through the UTCC. Their methodology has been the coordination of a variety of network tasks which when taken in the aggregate focuses on unifying various telecommunication efforts.

Washington

The Wide Area Network (WAN) Services provides Department of Information Services (DIS) customers with statewide, voice, data, and video transport. This service aggregates logical circuits into a volume transport facility. The WAN represents the collective "market basket" of most state agencies, enabling the cost of transport and related services for the state to be less than other alternatives.

DIS manages several large statewide networks that provide customers with connectivity and access to a number of mainframe and mid-size computer systems. These networks utilizes TCP/IP, IBM's SNA and Unisys' DCA. An asynchronous dial-up service (Dial-Access) is also supported on the System 390 and Unisys mainframe systems. The Dial Access service utilizes a number of Value Added Network (VAN) services to support the delivery of Dial-Access.

Since 1994, the state has operated a statewide system of information kiosks called Washington Information Network Kiosks. They provide citizens with access to information on government services, register for work with the Employment Security Department, search job openings, or review the Department of Revenue's listings of unclaimed property.

Wisconsin

In 1993 a Blue Ribbon Task Force on Telecommunications recommended:

- establishing an advanced telecommunications infrastructure throughout the state
- creating a statewide information technology plan with an emphasis on telecommunications
- linking individual state agency telecommunications plans and procedures with a comprehensive state plan
- regulatory policies to foster competition
- universal service funding mechanisms
- elimination of policy barriers to telecommunications uses

One outcome is BadgerNet, a project to create a new state telecommunications infrastructure. The Department of Administration (DOA), is rebuilding its telecommunications infrastructure, including the State Telephone System (STS) and the Consolidated Data Network (CDN). BadgerNet has about 11 times the capacity at about one-third the cost of the current network. Cost to access the BadgerNet network from any school or library in the state is estimated to be about $500 for a T1 line. The TEACH Wisconsin program proposes to use BadgerNet, in conjunction with the PSC's rate discount program, to enable schools to get at least a T-1 line for no more than $100/month.

Ameritech, the state's largest telecommunications provider, has installed about 2,400 miles of fiber optic cable. Other providers also serve Wisconsin, but there are complaints that Ameritech is stalling on providing access to its network to competitors, as required under the Wisconsin Telecommunications Act, which:

- provided partial deregulation of local telephone companies (including the option of price regulation)
- creation of a universal service fund, retraining programs for displaced telecommunications industry workers

- creation of a public-private Advanced Telecommunications Foundation to make technology grants, among other provisions

A contract is in place with Norlight Telecommunications for SONET Backbone services, and a contract with AT&T is in place for long distance voice services. The BadgerNet team is currently working towards the completion of a number of other contracts for services and equipment to complete the BadgerNet Network. BadgerNet data and distance learning DS3 video services will be available in 1998, long distance service is currently available.

BadgerDial is a statewide service providing dial-in Internet access. Conceived as a means of providing state government employees with cost-effective Internet access from any part of the state, it has expanded to include public educators and librarians. The service is expected to provide the greatest benefit to public schools, public libraries, local units of government, and rural areas and smaller communities where it requires a long-distance call to access the Internet. The Department of Administration, Ameritech, WiscNet (the Internet provider), and the Department of Public Instruction worked together to obtain a TIIAP grant and supplemental state funding to help extend Internet access to rural, low-income schools over the coming year. There are now 270 BadgerDial users. The Department of Administration's Bureau of Technology, Policy, and Planning will support the expansion of BadgerDial to provide an affordable baseline Internet connection for every K-12 school in the state. The bureau will subsidize BadgerDial accounts for more than 300 teachers in low-income, rural school districts.

The governor's Task Force in Telecommunications and Ameritech have worked together to

- promote the use of video conferencing in Juvenile Court proceedings
- establish distance learning sites in West Central Wisconsin
- develop a state government video conference network
- link the Department of Social Services to state hospitals

Wyoming

The Wyoming Statewide Network (WSN) is a collection of leased lines providing T-1 bandwidth. The network is used for government voice and data communications, Internet access, and law enforcement and library needs, as well as the needs of the University of Wyoming and the state community college system.

The Wyoming Video Conference System (WVCS) along with six other government and university networks is carried on WSN. It is a self-supporting video conference developed by a coalition that included the University of Wyoming School of Extended Studies and College of Education, the state's community colleges, three University of Wyoming Outreach Centers, and US West. The effort was directed by the Department of Administration and Information's Telecommunications Division. The system transmits two-way compressed video and sound between 16 video conferencing studios in 13 communities. About half of all WVCS use is education-related, another 35 percent is used by local, state, or federal government uses, and the remainder is used by nonprofit organizations and private entities. Private sector groups must obtain sponsorship through a government entity.

The initial goal is T-1 service to every county seat in Wyoming and every city with 500 or more residents. There is support for the use of video conferencing technology and "store and forward" multimedia email for use in the criminal justice system, other branches of state government, and school districts. In addition, public information kiosks to facilitate access to all types of government services.

APPENDIX E

Charts, Maps And Illustrations

ANAP SUMMARY SHEET

SELECTED ANAP CITY	NUMBER OF CIRCUITS	INTERCITY COST	INTRACITY COST
AKRON	5	$ 1,259.62	$ -
ALAMOSA	57	$ 11,506.18	$ 1,172.94
ASPEN	8	$ 1,998.35	$ -
BOULDER	88	$ 10,220.83	$ 1,755.31
BRECKENRIDGE	7	$ 3,560.58	$ -
BRIGHTON	21	$ 8,315.09	$ -
BUENA VISTA	16	$ 2,740.07	$ 452.36
BURLINGTON	9	$ 1,162.83	$ -
CANON CITY	57	$ 5,795.85	$ 2,890.50
CASTLE ROCK	16	$ 6,541.30	$ -
CENTRAL CITY	7	$ 731.80	$ -
CHEYENNE WELLS	8	$ 576.00	$ -
COLO SPRINGS	199	$ 26,003.03	$ 8,370.43
CONEJOS	5	$ 1,214.09	$ -
CORTEZ	21	$ 4,847.64	$ 522.02
CRAIG	24	$ 2,865.54	$ -
CREEDE	5	$ 1,129.20	$ -
CRIPPLE CREEK	10	$ 3,807.16	$ -
DEL NORTE	5	$ 965.89	$ -
DELTA	19	$ 7,266.53	$ -
DENVER	717	$ 90,335.72	$ 23,448.44
DOVE CREEK	6	$ 575.59	$ -
DURANGO	68	$ 9,907.22	$ 2,087.52
EADS	7	$ 1,873.91	$ -
EAGLE	18	$ 3,745.32	$ -
FAIRPLAY	5	$ 113,704.29	$ 25,535.96
FORT COLLINS	96	$ 8,647.16	$ 4,330.28
FORT MORGAN	35	$ 7,290.17	$ 239.40
GEORGETOWN	7	$ 658.89	$ -
GLENWOOD SPGS	46	$ 14,547.59	$ 1,822.89
GOLDEN	39	$ 9,212.06	$ 46.90
GRAND JUNCTION	162	$ 52,245.93	$ 968.50
GREELEY	93	$ 15,314.63	$ 2,505.85
GUNNISON	11	$ 4,838.99	$ -
HOLYOKE	12	$ 2,865.23	$ -
HOT SULPHUR SPGS	13	$ 3,184.02	$ 62.30
HUGO	7	$ 523.25	$ -
JULESBURG	4	$ 1,178.71	$ -
KIOWA	2	$ 950.49	$ -
LA JUNTA	16	$ 2,981.91	$ -
LAKE CITY	6	$ 1,496.77	$ -
LAMAR	73	$ 10,592.76	$ 1,202.64
LAS ANIMAS	6	$ 662.48	$ -
LEADVILLE	10	$ 944.94	$ -
LIMON	37	$ 4,525.63	$ 1,219.47
LITTLETON	33	$ 8,497.50	$ 31.90
MEEKER	6	$ 1,414.57	$ -
MONTROSE	56	$ 21,794.27	$ 365.06

ORDWAY	10	$	1,219.12	$	-
OURAY	6	$	3,216.56	$	-
PAGOSA SPRINGS	7	$	780.30	$	-
PUEBLO	185	$	23,709.48	$	7,494.43
RIFLE	11	$	2,219.08	$	-
SAGUACHE	5	$	1,269.97	$	-
SALIDA	8	$	1,719.23	$	-
SAN LUIS	6	$	1,290.40	$	-
SILVERTON	5	$	1,737.08	$	-
SPRINGFIELD	5	$	622.79	$	-
STEAMBOAT SPGS	12	$	1,798.06	$	-
STERLING	22	$	5,321.58	$	-
TELLURIDE	5	$	3,169.26	$	-
TRINIDAD	23	$	4,052.75	$	-
WALDEN	4	$	928.75	$	-
WALSENBURG	14	$	1,160.34	$	494.69
WESTCLIFFE	4	$	186.96	$	-
WRAY	7	$	1,013.96	$	-
		$	552,433.25	$	87,019.79